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RECOLLECTIONS OF A STREET CORNER PUMP AND THE PROGRESS OF SIXTY YEARS[1]

By Professor YANDELL HENDERSON
YALE UNIVERSITY

THESE recollections center about an old pump on a street corner and some of the boys who used it: particularly one of the boys, Simon Flexner by name. The pump was on the southeast corner of Chestnut and Sixth Streets; the time was about sixty years ago, when I was nine or ten years old, and Simon Flexner just ten years older. Any city of our Midwest or South would do as well; but in fact the place was Louisville, Kentucky. This pump was merely the trunk of a tree—virtually a piece of telegraph pole with its center bored out—stood up in a well. A long curved metal arm with a knob on the end stuck out to the side and was worked up and down, first merely sucking air and then causing a flow of clear, cool and rather pleasant-tasting water. Hanging by a chain was a large metal dipper; it was so green with mold that in drinking from it I preferred to apply my lips to the edge close to the long handle. We children liked the pump and the water and the dipper, for in warm weather we could not only drink copiously but also dabble our bare feet in the splash and stream as the water ran off into the gutter or drained back into the well. There is no analysis of this water on record; nor were any bacterial cultures ever made from the dipper. But the following will give an idea of what might have been found if such an examination had been made and what Simon Flexner survived—for the good of humanity.

[1] This sketch is written as a testimonial to Dr. Simon Flexner, emeritus director of the Rockefeller Institute for Medical Research, on the occasion of his eightieth birthday.

The well below the pump was perhaps fifteen or twenty feet deep. The street was paved merely with a porous water-bound macadam, and there was no sewer, but only surface drainage. Any liquid in the gutter must in part have soaked into the subsoil and so have found its way into the well. But more important is the fact that not a hundred feet away from the well, in the backyard of the second building from the corner, was a cesspool. It was walled with brick and lime mortar, and as it was in constant use by a considerable number of people, it is as certain as the results of similar conditions elsewhere can make it that an appreciable seepage from the cesspool to the well went on continually.

Even this is not the full indictment of that pump and its dipper from which we drank the cool, pleasant-tasting water. The building on the street corner was an apothecary's shop, a "drug store" where the apprentice and clerk, Simon Flexner, sold us children candies, gum drops, licorice and sticks of colored peppermint, when we were well, and dispensed to our parents strong medicines—calomel, quinine and preparations of opium—when we were ill. Over that shop a doctor, one of the leading physicians of the town, had his office. His patients, with all manner of infectious diseases, including diphtheria and smallpox, drank from the pump by means of the common dipper on their way to and from his office. He specialized in skin diseases and was particularly well known for his success in the treatment of syphilis; for he had introduced from Europe and administered in his office the then newest treatment—the patient sat under a little tent of cotton cloth with only his head projecting, while a lamp below the chair vaporized mercury about his naked body. Many a syphilitic sore mouth drank from that dipper.

When the physician finished his office hours and went to dinner, he had merely to step across to his home in the house next door, the house with the above-mentioned cesspool. There were no fly screens then on the windows; but there were plenty of stables where this doctor, among others, kept the horses which drew his "buggy," as a doctor's car was called; and each of these stables had an unprotected pile of horse manure in which flies bred freely. Many of these flies, after picking up typhoid and other germs in appropriate places, flew to the dining room table, where this physician, his wife and four children, and his nephews, of whom I was one, enjoyed the bountiful American food of those days, including many good things no longer in market or too expensive now. Our sanitary protection was a coal-black Negro girl who, during dinner, waved a brush of long peacock feathers over the table so as to keep the flies on the wing and out of our milk and butter.

Speaking of that milk, there is one aspect of our present sanitation which, for me at least, has a drawback. Nearly all children then liked "cottage cheese," and I particularly liked the clabber or sour milk before the whey was drained off. To produce clabber, it was only necessary to set fresh milk over night in an open bowl in the kitchen, where it was warm. The milk was already sufficiently infected with lactic acid bacilli so that nature produced such clabber as the pure milk of nowadays yields only when treated with artificially grown organisms. Well might that milk yield clabber! It was brought from the dairy farm in a large can with a spigot sticking out of the back of the milk wagon and a line of pint and quart measures hanging alongside, which the milkman used again and again, unwashed, to measure off the white and foaming stream in the full exposure of a very dusty street. Out at the dairy farm there was no ice; but there was a fine spring house where the milk was set in large flat pans in the running water for the cream to rise. To skim off this cream, the milkman tilted one of those pans over a smaller vessel and then blew his breath vigorously over the surface, so that the upper layer of cream flowed off—a sort of pneumatic skimming.

All of us children had all the common diseases of childhood at an early age and several diseases that are not now common. I had typhoid at the age of six. On summer evenings our parents sat on the front door steps, chatted with their friends and drank lemonade or mint juleps, of which we children afterward got the sugary leaves, moist with good Bourbon whiskey, to suck. Until we were put to bed under mosquito bars we were busy slapping the anopheles mosquitoes which bred luxuriantly in numerous ponds in vacant lots within the city limits.

Whenever we seemed at all unwell, we received immediately ten grains of quinine with calomel in powder form on the point of a knife. Some of the older people had lost their teeth from being salivated with excessive calomel: this was so common that the children used the word "salivate" as a slang synonym for administering a crushing defeat: thus it would be said of a fight in which Bill thrashed Jack that "Bill hit so hard that he simply salivated Jack." We did a good deal of fighting in those days: the war was recent, and sentiment in Kentucky was pretty evenly divided. Yellow fever did not reach us; but it was feared, for it had one summer come as near as Memphis, Tenn. Smallpox was common, especially among the Negroes, but we were protected by vaccination. For this purpose, on a day in the first year of my life my uncle, the afore-mentioned doctor, scratched three large areas on my left arm, as evidenced by three large scars which I still bear. To these areas was applied

the pus from the arm of another person; and the "takes" were so successful that my first contribution to preventive medicine came from these sores, for a dozen other persons were vaccinated from them. The calf was not the only source of vaccine in those days, although the material from such human cultures sometimes carried other organisms than those of the cowpox. Long afterward Dr. Flexner himself told me that probably at that time no "calf vaccine" was available: but the crust or scab above a healed vaccination pustule, usually wrapped in a piece of white paper, was carried in the vest pocket of the doctor.

Pulmonary tuberculosis was common and the frequency of other forms of tuberculosis was attested by the number of humpbacks that we saw on the street. Of other diseases, diphtheria was most feared and some of my earliest friends died of it. Twice I had deep, penetrating and non-bleeding wounds, once from a thorn in my foot and again from a rusty nail in the oat bin in the stable. I escaped; but one of my friends, who tore his hand on a barbed wire fence when I was ten or twelve years old, died of lockjaw. Nothing was or could be done for him; there was no antitoxin then. Indeed, we who survived must have borne charmed lives, for I carried up to middle life a pair of tonsils bad enough to have been the cause of acute rheumatism or heart disease at any time during forty years. The tops might have been snipped off; but enucleation was then not done. Asthma and hay fever went untreated. For a siege of boils on my feet, my uncle, the doctor who had the office over the "drug store" (a very good doctor too for those days), prescribed a tonic containing iron. A similar outbreak on the same feet many years later was treated with much more rapid success by omitting the tonic and merely disinfecting the shoes with formaldehyde vapor. (Long afterward I published that mode of treatment.)

In spite of all this and much more, we were far better off than our ancestors only a generation or two earlier: when we had a fever, we were not bled, and could drink all the water we wanted. Also surgical operations, although not as yet aseptic, were done under anesthesia—chloroform poured liberally on a towel.

Perhaps the reader suspects that the people who drank from that pump, and whose sanitary ignorance it symbolized, were an unusually backward and ignorant group. To prove that this was not the case, let me describe two families in the neighborhood. The oldest member of one of them, my grandfather, had been the dean of the first medical school west of the Allegheny Mountains and a friend of the great MacDowell. He was also a geologist of distinction, a writer on medical subjects whose works were highly prized and a physician who was so much in advance of his time that he gave as small doses of as few drugs as his patients would permit. One of his sons was the physician over the drug store. Another was a leading surgeon in the southwestern states and had been the chief medical officer of the Confederate Army operating in Tennessee and surgeon on the staff of General Albert Sidney Johnston. In fact, it was a family of distinguished medical men.

The other family had not been so long settled in the country, but they were already respected for intelligence and scholarship. The father had been born at Prague in Bohemia, and had taught school in the university city of Strassburg before emigrating to America. At the time here referred to, he and his wife, who was born on the Rhine, and their nine children were settled in Louisville on the Ohio, and one of the sons was the apprentice in the drug store. Another of the sons, Abraham Flexner, was sometimes about the store out of school hours and also drank from the corner pump.

Sixty and odd years have passed. Starting, as it were, from that pump on the corner and the drugs on the shelves in the shop back of it, Simon Flexner advanced to medicine and began his training in the meager two-year course, lacking in nearly everything that now constitutes medical science, in the medical school at Ninth and Chestnut Streets, where two of the professors were my uncles, the physician and the surgeon mentioned above. The school got its first microscope while Simon was there. Then he went to the Johns Hopkins Medical School as student and later was assistant to Dr. William H. Welch, who had recently brought pathology from Germany. Thus Simon Flexner went forward until he became not only an investigator of the first rank, but also director of the vast service of the Rockefeller Institute for Medical Research.

Meanwhile his brother, Abraham Flexner, who likewise as a child must have imbibed enthusiasm for medical progress with the waters from that pump, went through Johns Hopkins College; then, for a time, into teaching at Harvard; then into the investigation of prevalent methods of teaching and particularly medical education; and so, from one step to another, until he became secretary of the General Education Board and wrote the great "Report on Medical Education in the United States and Canada" (Carnegie Foundation, 1910) which wrought such a revolution in medical teaching and investigation as no previous age had ever seen.

Others of the nine Flexner children, who all some-

times drank from that pump, have had distinguished careers—not indeed in medical science, but all notable for scholarly ability, broad humanity and public spirit.

Evidently those who drank the waters of that pump sixty years ago gained from it or from some other source such inspiration as Greek legend supposed that the poets drew from the spring of Arethusa on Parnassus, the fabled mountain of the Muses. And if men with such inspiration have achieved results verging on the marvelous within one generation their achievements should be an inspiration also for those who are to come after them in what is yet to be done. Truly if, as Oliver Wendell Holmes stated at the time when the cool water was flowing from that pump, the "state of medicine is the best index of the grade of a civilization," civilization in the sixty odd years since then has advanced as never before.

Nothing in this advance is more striking than the decrease in the deaths among children. In the time when Simon Flexner and his brothers passed the perils of birth, infancy and childhood, as in all previous centuries, ten or more children per wife or succession of wives worn out with child-bearing were not an unusual number born in a family; but often few, and sometimes none, survived to be grown. Now it is the knowledge of the diseases of childhood won by the men who drank from that pump and others like it that balances the diminished birthrate and that generally assures to us who now are old the survival and affection of our children and grandchildren.

INITIATIVE IN RESEARCH[1]

By Dr. COLIN GARFIELD FINK
COLUMBIA UNIVERSITY

FORTY years ago industrial research laboratories were practically unknown. To-day no industry can exist without a research laboratory. The phenomenal advances in aviation, electric communication, textiles, corrosion-resistant metals, plastics, vehicles of locomotion, paints and pigments, etc., etc. (to mention but a few of the hundreds of new products and processes introduced during these past forty years) would have been well-nigh impossible without the industrial research laboratories with their facilities and highly trained personnel.

And these research laboratories are not confined to this country, although by far the larger majority of them are now in America. But there are many laboratories in Europe, in Canada, in Russia and elsewhere that are of the very highest type and that have made important contributions to science and industry.

It has often been said that there is a very decided difference between American and European research and that American research was largely of the "development" type, whereas European was predominantly fundamental or radical research. During the early years of industrial research in this country the above statement was largely true. But it is no longer true to-day.

To avoid any misunderstanding, since we are going to enlarge upon "fundamental research," the usual interpretation of fundamental or radical research is that devoted to finding entirely new products or entirely new processes radically different from anything that has gone before. For example, we have John W. Hyatt's work on the production of billiard balls out of a plastic in place of elephants' tusks. This is a case of fundamental research, whereas development research would imply how to raise more elephants or how to alter their feed to develop longer and bigger tusks.

Another example is the research of D. MacFarlan Moore on electric lighting. Abandoning the incandescent lamp he devoted his energies to discovering the secret of the firefly's glow. To-day the fluorescent lamp is the outcome of Moore's researches, granting of course that in recent years a host of researchers have contributed to this fluorescent lamp. But here again this latter-day research was largely of the "development" type.

FUNDAMENTAL RESEARCH

Personally, during my forty years of research experience, I have always been interested primarily in *fundamental* research rather than development research. And my advice to the young student who has inclinations toward research is to choose the fundamental type rather than the development type. We grant that "the work is harder, the standards higher and the discipline more rigorous" than in any other phase of scientific or technical occupation. But on the other hand the interest and excitement, the stimulation and satisfaction are greater by far than in any other field of scientific or technical endeavor.

To give you some idea of what we mean by *initiative in research* we shall give you brief accounts of a few of the many researches that have been carried out under our direction.

THE PLATINUM SUBSTITUTE PROBLEM

When Edison made his first incandescent lamps at Menlo Park he used comparatively thick platinum

[1] Lecture delivered at the Stevens Institute of Technology on April 14, 1943.

wires in the seal to carry the current to the filament. Examining some of the old broken lamps we found in the dump at Menlo Park we estimated that at present prices for platinum the cost per lamp approximated $5.00. But in Edison's day platinum was cheaper than gold. The problem of finding a leading-in wire decidedly cheaper than platinum was a very old problem—at least 30 years old—when brought to our attention. At the time I was carrying out researches at the Edison Lamp Works in Harrison, N. J.

It was generally agreed that the reason why platinum was being used as an air-tight seal in glass was on account of its coefficient of expansion—almost identical to that of glass, the lead potash glass universally used at the time. Accordingly, it was again generally agreed that any wire that was to be used in place of platinum would have to have the same coefficient of expansion as that of glass. But this idea had persisted for thirty years without bearing fruit: And it occurred to us that there must be something radically wrong with this idea—or possibly that some factor other than coefficient of expansion was at the basis of the solution of the problem. While our own efforts proceeded along fundamental lines, our works manager encouraged "development" research, that is, using shorter pieces of platinum and thinner pieces welded between ends of short copper wires, using platinum ribbon in place of platinum wire, etc., etc. Our platinum budget ran to 7½ million dollars a year and every bit of platinum per lamp saved was appreciable.

We tackled the problem from an entirely different angle. We argued that if a metal or alloy could be found that would adhere tenaciously to glass and would be very soft (like rubber, for example) then, no matter what the coefficient of expansion of the metal might be, this metal would expand and contract as dictated by the more rigid glass.

Accordingly, we selected five commercially available metals and annealed these "dead soft," as we say in metallurgy: nickel, copper, cobalt, iron and silver. To compare results we added platinum.

These six metals were in the shape of thin wires. These wires were sealed into glass and lamps were made up. The lamps were allowed to stand for three days and then were tested for leaks. The performance was surprisingly good, even though many leaky lamps had developed on standing. Examining the seals under the microscope we observed that the *copper and cobalt wires* showed that the wetting quality or the union between glass and metal was exceptionally good—even better in certain respects than between glass and platinum in spite of the fact that the coefficients of expansion for copper and cobalt are much higher than that for platinum—cobalt 138 per cent. of platinum and copper 188 per cent. of platinum; in other words, both cobalt and copper should contract away from the glass on cooling.

To further test our hypothesis we prepared another batch of samples of the six metals: But this time we prepared them in the shape of fine ribbons 3/16 inch wide and again thoroughly annealed.

We next took a glass rod and mounted it horizontally, then heated it at a half a dozen points and sealed the ribbons onto (not into) the glass. After cooling we attached weights to the other ends of the ribbons. Much to our satisfaction we found that the copper ribbon would support the heaviest weight, next the cobalt ribbon, then the nickel, the silver and the platinum ribbons and finally the iron ribbon which showed the poorest adhesion.

On the basis of these findings we developed a thin-walled copper tube seal[2] which was made to carry either a fraction of an ampere or several hundred amperes. The adhesion of copper to glass was so perfect that lamp tests showed fewer leaks than with platinum. From this first product a second one followed, the so-called dumet wire. In this we again applied the thin tube of copper but filled the copper tube with an alloy of nickel and iron which had a coefficient of expansion lower than glass.[3] This platinum substitute (dumet) is to-day used in all radio tubes, electric lamps and dozens of other types of evacuated glass containers.

THE INSOLUBLE ANODE PROBLEM

When this problem was brought to us the specifications were as follows: The anode must be practically insoluble in a copper sulfate solution containing nitric and hydrochloric acids besides sulfuric. A further specification was that the anode must not contain any element which even though entering the solution in minute quantities might co-deposit with the copper and thereby seriously affect the electrical conductivity.

The solution of this problem was approached from two angles: development research and fundamental research. In the development research we started out by testing anodically well-known acid-resistant alloys such as duriron and nichrome and modified the composition of these to increase their acid resistance. Many hundred alloys were made up, but not one of these was entirely satisfactory.

In the fundamental research approach we considered carefully the reactions that took place at the anode. There were principally two anodic reactions in which we were interested. One was the dissolution of metal—which we wanted to be practically zero—and the other was the evolution of oxygen—which we

[2] Fink and Koerner, U. S. Pat. 1,273,758 (July 23, 1918).

[3] Brit. Pat. 23,775 (October 17, 1912); U. S. Pat. 1,498,908 (June 24, 1924).

wanted to be 100 per cent. We concluded that our efforts be bent toward facilitating and promoting the evolution of anodic oxygen. Accordingly, we conceived the idea that if we used a copper plate and covered the surface with an oxygen catalyst the copper would not go into solution. We tried out several catalysts and lo and behold the scheme worked. But there was one hitch in the scheme: It worked only when current was applied: Shutting off the current with the copper plate still immersed would cause the plate to dissolve. Accordingly some provision had to be made for the protection of the copper plate during current interruptions. This part of the problem was solved by adding about 20 per cent. silicon to the copper so that the final anode[4] as introduced at Chuquicamata and in use for many years is a copper silicide alloy with a catalytic surface. The catalysts are manganese dioxide, tin oxide and lead dioxide.

ALPLATE

Alplate is the name applied to aluminum-coated steel, aluminum-coated nickel and other metals. The problem of substituting molten aluminum for molten zinc in hot galvanizing was a very old problem when we started our research. Many schemes had been tried, but not one of these developed into a commercial process. One big stumbling block in the past had been the refusal of the aluminum to wet the steel or other metal. You can stick an iron rod into a pot of liquid aluminum and upon withdrawing it the rod will be just as free from aluminum as it was to begin with.

In the development type of research investigators imitated the detailed practice used in hot galvanizing trying out various fluxes, temperatures, speeds, additions to the aluminum, etc. But all these experiments had failed.

In applying the principles of fundamental research it was necessary to carefully study the reason why liquid aluminum would not wet steel. It was not enough, however, to conclude that it was an oxide film on the aluminum that prevented the formation of a good bond between aluminum and steel. The problem now resolved itself into finding a method or means of avoiding the formation of the oxide film or adding some reagent that would counteract the formation of the oxide of aluminum.

One scheme that gave us much encouragement was the introduction of the steel rod or steel strip through a restricted orifice in the pot filled with molten aluminum. But this was not enough: Results were not uniformly good.

The next step solved the problem satisfactorily. It is well known that aluminum oxide is one of the most refractory oxides known and very difficult to reduce to metal. However, there is one reducing agent that will produce the metal and that is atomic hydrogen. It is also well known that iron will dissolve or take up hydrogen and that the amount taken up varies with the temperature. These were the building stones out of which we constructed our final process.

The steel to be coated with aluminum is heated in an atmosphere of hydrogen and allowed to absorb and adsorb as much hydrogen as possible. Then the steel passes into a bath of molten aluminum kept at a temperature *lower* than that of the hydrogen furnace so that the hydrogen is forced out of the steel during the very instant that the steel contacts the aluminum. As a net result a strongly adherent uniform coating of aluminum is produced on the steel.[5]

THE RESTORATION OF BADLY CORRODED BRONZ ART OBJECTS

This problem was brought to us by the Metropolitan Museum of Art. The various methods employed up to that time were very radical. In most cases knives, chisels and hammers were used, in other cases strong acids. But the results achieved were very unsatisfactory and the "restored" product obtained was seldom of any value from an artistic point of view.

Our approach to the problem was based on entirely different principles. We observed in a number of bronzes that the outer contour of the crust of corroded metal was an enlargement of a design which undoubtedly was the original design of the bronze. Further study and experiments on corroded bronze and copper objects led to our discovery that "the detail of design is retained by the crust." Of this we were very certain, and the next step was to find a method of reversing the process of corrosion and bringing back the original design. We decided that an electrochemical cathodic process was the only practical solution. After some further experimentation the following procedure was standardized and this is now used all over the world: The corroded object is suspended as a cathode in a 2 per cent. solution of sodium hydroxide and a few milliamperes passed through the solution. Very gradually the carbonates and oxides are reduced back to metal. The electric current required is a matter of a few milliamperes per square foot of surface of the bronze or copper object. And the time required is usually a matter of days or weeks, depending upon how far the corrosion of the metal has proceeded. In many cases the objects submitted to us for restoration have no trace of metal left, just a mass of corrosion product.

This research on the restoration of badly corroded bronzes has led to other developments, notably the

[4] U. S. Patents Nos. 1,441,567 and 1,441,568 (January 9, 1923).

[5] U. S. Pat. No. 2,082,622 (June 1, 1937).

authentication and attribution of various objects of art and various articles of antiquity not necessarily artistic. The very observations made during restoration are among the most crucial observations in deciding whether a piece of metal, stone, wood or cloth is old or of recent origin.

OTHER RESEARCHES

In the few examples above we have tried to indicate the main points of difference between development research and fundamental or radical research. We might go on to tell you how these principles of radical research were applied to:

(1) Our researches on chromium plating and the discovery of the relatively narrow limits of catalytic agent quantities that must be added to the plating bath—a radically new observation, never before applied to any plating bath.

(2) Our various researches on tungsten, its crystal structure, crystal growth, its ductility, etc.

(3) Our research on bright nickel plating.

(4) On high chrome-irons.

(5) On electrolytic manganese.

(6) Our researches on corrosion of metals and various means of combating same, etc., etc.

NEW PROBLEMS

The world is full of new chemical and electrochemical problems that await the young investigator. Typical of these many "yet-to-be-solved" problems is the one on *rubber:* Although there are several synthetic rubbers that closely compete with the natural variety, a "complete" substitute is yet to be found. Might it not be worthwhile to investigate the possibilities of growing rubber trees in the temperate zone? We have had definite indications in our experiments that the tropical rubber tree, *hevea brasiliensis,* may be converted into a deciduous tree of the cooler climates by proper treatment and control of the soil constituents.

Among the numerous other problems that await the young lad with vision and courage are:

(1) The perfection of electric lighting ten times as efficient as any present type.

(2) An improved automobile gas engine operating at three or four times the efficiency of the present one.

(3) A paint for wooden structures that is rainproof and sunproof.

(4) An alloy of aluminum as resistant to fatigue as steel.

(5) A metal or other material to take the place of our rapidly dwindling resources of copper—or of lead.

(6) A material to take the place of leather for shoes with all the good, or even better, qualities of leather.

And many, many more problems.

Throughout the ages there have always been young men endowed with the research spirit or research instinct. Very often this is a latent talent that needs to be aroused. And the best procedure in arousing this most valuable talent is to become interested in one or the other phase of science or engineering and then to select one or the other individual topic and apply oneself diligently to this. But reading alone is not sufficient in preparing for research. The laboratory or workshop—no matter how primitive and incomplete—is a most essential adjunct. Reading without experimentation hardly ever leads to the desired results. On the other hand, experimentation with little or no library work frequently leads to radical discoveries.

And in conclusion let me say to the young man: The opportunities in research are greater to-day than ever before. And the chances of finding new products and new processes have never been equalled in the past.

OBITUARY

WILLIAM FRANCIS MAGIE
1858–1943

WILLIAM FRANCIS MAGIE was born in Elizabeth, N. J., on December 14, 1858, and died in Princeton on June 6, 1943. He was the son of William Jay Magie, a former chancellor of the State of New Jersey. He graduated from Princeton as valedictorian of the class of 1879, a class that had many other distinguished members, including Woodrow Wilson.

After graduation he remained in Princeton as assistant to Dr. Brackett, then Henry professor of physics. Having decided to make physics his life work it was natural at that time for him to go to Germany to pursue advanced work. He matriculated at the University of Berlin and took his doctor's degree under the direction of Helmholtz in 1885. His dissertation was an experimental study of the theory of capillarity.

Returning to Princeton he was appointed to an instructorship in physics during the presidency of James McCosh, advancing to a professorship in 1890. In 1889 Dr. Brackett founded the graduate school of electrical engineering at Princeton and devoted most of his attention to it. Although Dr. Brackett remained the chairman of the department of physics, Magie became more and more responsible for the actual administration of the department, and its expansion from very small beginnings was very largely

the result of his efforts. Dr. Brackett retired in 1909 and Magie was appointed Henry professor in 1910; he retained the chairmanship of the department until his retirement in 1929.

Soon after returning from Germany Magie began the investigations which formed his main contribution to research. These had to do with the properties of solutions, particularly their specific heats and volumes. He not only gathered together the various measurements made by others but made many determinations himself for the purpose of advancing the theory of solutions. His experimental work was done with great skill.

Magie was one of the small group of physicists who met in New York in 1899 to found the American Physical Society. He was a member of the first council of the society and its president during the year 1911–12. He was vice-president for Section B of the American Association for the Advancement of Science and gave his presidential address at the New Orleans meeting in 1905. He was also a member of the American Philosophical Society.

In university affairs in general Magie took a very active part. For many years he served as clerk of the faculty and was an influential member of many of the important committees of the faculty. In 1912 he was appointed dean of the faculty, a position he held until 1925. These administrative duties took so much of his time and attention that in his later years he gradually gave up his activities in research, although he always maintained a keen interest in the work done by his colleagues in the department.

His publications, other than his papers in his field of research, included a revision of the "Text-Book of Physics" by Anthony and Brackett, a text which was widely used in the latter part of the last century. He was a firm believer in the value of the study of physics for the general student, particularly the historical development of the principles. With this in view he wrote his "Principles of Physics" which gives an admirable account of the rise and content of physical theories. He was a master of clear and concise exposition in the best of English. He also translated Christiansen's "Theoretical Physics," and edited the important contributions of Carnot, Clausius and Thomson to the second law of thermodynamics for Harper's series of Scientific Memoirs. When the series of source-books in the sciences was being planned Magie was asked to contribute the volume on physics. This work he began on his retirement in 1929 and he devoted much time and energy to compiling and translating extracts from the memoirs that have had the greatest influence in the development of physics. He was often called upon to speak and write about the life and work of Joseph Henry, a subject of particular interest to him because of Henry's relation to Princeton.

The honorary degree of LL.D. was conferred upon him by the College of Wooster in 1916, and Princeton gave him the honorary degree of D.Sc. upon his retirement.

No account of Dean Magie's life would be at all adequate without an appreciation of his loyalty to his associates and the very real affection that all of those who had the privilege of working with him felt for him.

In 1894 he married Miss Mary Blanchard Hodge of Princeton, who survives him, as does his sister.

E. P. Adams

RECENT DEATHS

Dr. Harry B. Meller, research engineer of Pittsburgh, Pa., died on June 27 at the age of sixty-four years. Dr. Meller was chief of the air pollution investigation which has been conducted at Mellon Institute since 1923.

Dr. W. E. Saunders, ornithologist, of London, Ont., died on June 28 in his eighty-second year.

Dr. Abby Lillian Marlatt, from 1913 until her retirement in 1939 director of the department of home economics at the University of Wisconsin, died on June 23 at the age of seventy-four years.

Dr. B. Raymond Hoobler, until his retirement as emeritus professor in 1936 professor and head of the department of pediatrics of the College of Medicine of Wayne University, died on June 11 at the age of seventy-one years.

John R. Peters, petrographer at the U. S. Army Testing Laboratory, Mariemont, Ohio, died on June 24. He was twenty-seven years old.

SCIENTIFIC EVENTS

THE ENRICHMENT OF WHITE FLOUR

The War Food Administration announces that a public meeting to consider the advisability of requiring all white flour distributed for human consumption to be enriched will be held at 10 A.M. on July 21 in the South Agriculture Building Auditorium, Washington, D. C.

Enrichment of white flour and bread has the endorsement of leading scientific and medical organizations, and of a large part of the milling and baking industries. Under wartime food conditions a further increase in consumption of white flour is expected and its enrichment would aid in adequate consumption of important vitamins and iron. An inadequ

supply of these vitamins leads to nervous instability and other disturbances, with resulting loss of working efficiency. There is a Federal standard for enriched flour, which at present requires specific quantities of thiamin (vitamin B_1), niacin and iron. Beginning on October 1, the vitamin riboflavin also will be required.

The need for a wide distribution of the vitamins and minerals contained in enriched flour was the basis for the provision of Food Distribution Order No. 1 requiring enrichment of all bakery white pan bread. In order that all white bread, whether baked in the home, in an institution or in the commercial bakery, may contain these essential nutritive factors, it has been proposed to enrich all white flour distributed for human consumption.

A proposed order has been drafted in accordance with recommendations received from the National Research Council. The effective date of the order, if issued, will be made not less than 120 days after its date of publication, affording millers who have not enriched their flour an opportunity to obtain necessary equipment and materials. Likewise bakers who are enriching bread by other means will have an opportunity to consume their stocks of enrichment agents.

Persons unable to attend the public meeting may address any communications and expressions of opinion to the Director of Food Distribution, War Food Administration, Washington, D. C., to be received not later than July 26.

The proposed food distribution order reads:

1. *Provisions.* Except as hereinafter indicated, no miller, blender or other person who manufactures or prepares white flour for sale for human consumption may sell or deliver the same unless it conforms to the amended definition of "Enriched Flour" contained in the proposal under the Federal Food, Drug and Cosmetic Act, published in the Federal Register of June 5, 1943, pages 7511–7514. No broker, jobber or other person who handles, repacks or otherwise deals in white flour may sell or deliver the same for human consumption with knowledge that it is not enriched.

(The amended definition describes enriched white flour as containing in each pound not less than 2.0 milligrams of thiamine, 1.2 milligrams of riboflavin, 16 milligrams of niacin or niacine amide and 13 milligrams of iron. Calcium and vitamin D remain optional ingredients as heretofore.)

2. *Exemptions.* The provisions of this order shall not apply to (1) flour delivered prior to the expiration of a period of 120 days after the date of issuance of this order, (2) flour milled and packaged for retail sale prior to the effective date of this order, and (3) flour which may be specifically exempted from time to time by the Director.

3. *Records and reports.* Each person required by the order to enrich flour shall keep and preserve for not less than two years such records as may be necessary to show (1) the volume of his sales of enriched flour, (2) the volume of his sales of flour not enriched, (3) the volume of the different ingredients used by him to enrich flour, and (4) the names of persons from whom such ingredients were obtained.

AWARD OF GUGGENHEIM FELLOWSHIPS

IN order to improve the quality of education and the practice of the arts and professions in the United States, to foster research and to provide for the cause of better international understanding, the John Simon Guggenheim Memorial Foundation, established by former United States Senator and Mrs. Simon Guggenheim as a memorial to a son who died on April 26, 1922, offers a limited number of fellowships, tenable under the freest possible conditions, for research in any field of knowledge and for creative work in any of the fine arts, including music. The fellowships are awarded by the trustees upon nominations made by a committee of selection.

The stipend in normal cases does not exceed $2,500 for a year of twelve months. The tenure of fellowships will be adjusted to the purpose and scope of the studies of each individual. Appointments will be made ordinarily for one year; but plans which involve two years' work are considered by the trustees. Fellowships for 1943 have been announced. These include the following in the sciences:

Dr. Edgar Anderson, professor of botany, Washington University, St. Louis; geneticist, Missouri Botanical Garden: A study of the races of *Zea mays* with special reference to Mexico and the Southwest.

Dr. Solomon E. Asch, assistant professor of psychology, Brooklyn College: Continuation of the preparation of a book on the formation and change of opinion and attitude. (Renewal.)

Dr. Emma Lucy Braun, associate professor of plant ecology, Graduate School of Arts and Sciences, University of Cincinnati: Studies of the ecology and taxonomy of the deciduous forest.

Dr. Barbara Stoddard Burks, research associate in psychology, Columbia University: Studies in the field of heredity and environment in human development, in particular to gather materials for a book on the role of twins in the study of man.

Dr. Kenneth Edward Caster, assistant professor of geology, University of Cincinnati: A field study of the stratigraphy, paleontology and paleo-ecology of the Paleozoic strata of the northern sector of the Andes, with particular reference to the age, relationships and fossil faunas of the Andean Devonian sequence as developed in Colombia and adjacent Venezuela.

Dr. Tilly Edinger, research associate in paleontology, Museum of Comparative Zoology, Harvard University: A

study of the tooth replacement in Amphibia and Reptilia, particularly primitive fossil types, with special reference to the history of dental succession in the evolutionary line leading from ancestral fishes to mammals.

Dr. Henry Paul Hansen, assistant professor of botany, Oregon State College: A study of Post-Pleistocene forest succession and climate in the Pacific Northwest.

John Francis Hanson, teaching fellow in entomology, Massachusetts State College: A study of the comparative morphology of all accessible genera, species and especially type specimens of Plecoptera (stoneflies) in the United States.

Dr. Floyd Alonzo McClure, professor and curator of economic botany, Lingnan University, Canton, China (on leave): Continuation of the preparation of a revision of the Chinese genera of the Bambusaceae. (Renewal.)

William Vogt, associate director, Division of Science and Education, Office of the Coordinator of Inter-American Affairs: Preparation of a monograph on the ecology of the guano birds of Peru.

The Committee of Selection consisted of Dr. Frank Aydelotte, Dr. Wallace Notestein, Dr. Linus Pauling, Dr. Florence R. Sabin and Dr. Edwin Bidwell Wilson.

Applications for fellowships must be made in writing on or before October 15, by the candidates themselves, in the form prescribed, addressed to Henry Allen Moe, *Secretary General,* John Simon Guggenheim Memorial Foundation, 551 Fifth Avenue, New York, N. Y. Final selection of fellows for 1944–45 will be made in March, 1944. Application forms will be mailed upon request.

AWARDS OF THE SOCIAL SCIENCE RESEARCH COUNCIL

THIRTY-EIGHT awards, amounting to $48,000, for the academic year 1943–44 have been announced by the Social Science Research Council, New York. The awards provide for study and research in the fields of economics, political science, sociology, statistics, political, social and economic history, cultural anthropology, social psychology, geography and related disciplines.

Eight of the awards, carrying a basic stipend of from $1,800 to $2,500 for twelve months, plus travel allowance, cover post-doctoral research training fellowships to men and women under thirty-five years of age who possess the Ph.D. degree or its equivalent. These fellowships are granted for the purpose of amplifying and sharpening the research training and equipment of promising young investigators through advanced study and field experience.

Seven appointments are pre-doctoral field fellowships which carry a basic stipend of $1,800 for twelve months plus travel allowanee. The recipients are graduate students under thirty years of age who have completed all the requirements for the doctorate except the dissertation. The purpose of these awards is to offer the opportunity for first-hand contact and experience with the phenomena of social science in the raw, as a supplement to formal graduate study.

The remaining twenty-three awards are grants-in-aid designed to assist mature scholars in the completion of research projects already well under way. These grants average about $580 this year, but individual grants in any year do not ordinarily exceed $1,000. Five of the appointments were made through a special fund granted solely for the purpose of assisting and encouraging the research of social scientists in the South. The objectives and requirements for eligibility are the same as those governing the national grants-in-aid, but applications are restricted to thirteen southern states.

FOREIGN MEMBERS OF THE ROYAL SOCIETY, LONDON

Nature gives the following particulars in regard to the work of Professors Goldschmidt and Houssay, whose election to foreign membership in the Royal Society, London, was recently announced in SCIENCE.

Professor V. M. Goldschmidt has made outstanding contributions in each of the fields of petrology, crystal chemistry and geochemistry. His early studies in rock metamorphism marked a major advance in the correlation of the chemical and mineralogical composition of thermally reconstituted rocks and contained the first successful essay towards a systematic classification of rock-mineral assemblages in the light of the phase rule. The leader of great schools of geochemistry both at Göttingen and Oslo, Goldschmidt has for many years devoted his attention to the discovery of the principles governing the terrestrial distribution of the elements: in this program his classical researches on the crystal structure of ionic compounds were early achievements and may be regarded as laying the foundation of the science of crystal chemistry. His exhaustive series of investigations on the chemical composition of rocks and minerals has revolutionized our knowledge of the distribution of the minor constituents of the earth's crust, while his similar studies on meteorites have brought a special contribution to the problem of the chemistry of the earth's deep interior. It is in these comprehensive researches, both geochemical and crystallochemical, that Goldschmidt has contributed in such large measure to the present-day picture of the geochemical evolution of matter within the lithosphere.

Professor Bernardo Alberto Houssay, of Buenos Aires, is one of the outstanding men of science of Latin America. He has held the chair of physiology in the University of Buenos Aires since 1919, and has made his laboratory a leading center for endocrine research. His most remarkable discoveries concern the effect of the anterior pituitary body on carbohydrate metabolism; he showed that although the removal of the pancreas alone will cause

diabetes, yet if the anterior lobe of the pituitary is removed at the same time the animal has no glycosuria and stays in reasonable health. Further analysis made it clear that the anterior lobe of the pituitary secretes a hormone with an opposite effect on sugar metabolism to that of insulin, and that it is the absence of this hormone in the "Houssay animal" which accounts for the lack of glycosuria when the pancreas is removed. Many other chapters in the complex story of endocrine interactions have been worked out in Professor Houssay's laboratory and he has recently dealt with the problem of renal hypertension and the nature of the toxic substance which may be liberated by a diseased kidney. He is an honorary member of the Physiological Society and has published various papers in the *Journal of Physiology*.

MEDICAL FELLOWSHIPS OF THE NATIONAL RESEARCH COUNCIL

AT the February meeting of the Medical Fellowship Board of the National Research Council, Washington, D. C., of which Dr. Francis G. Blake, Sterling professor of medicine at Yale University, is the chairman, one fellowship in the medical sciences, a renewal, was awarded. Seven appointments, including two renewals, were made to fellowships in the filterable viruses and orthopedic surgery. A list of the successful candidates and the institutions where they are to work follows:

Medical Sciences

Lester J. Talbot (renewal), New York University College of Medicine.

Filterable Viruses

Edward H. Anderson, Vanderbilt University.

H. Chandler Elliott (renewal), University of Toronto.

I. William McLean, Jr., Duke University School of Medicine.

Alison H. Price, University of Michigan (declined appointment).

Hugh Tatlock, Yale University School of Medicine and the Acute Respiratory Diseases Commission Laboratory, Fort Bragg, N. C.

Herbert A. Wenner, Yale University School of Medicine and the Johns Hopkins University.

Orthopedic Surgery

Maxwell F. Kepl (renewal), Tulane University of Louisiana.

Welch fellowships in internal medicine were awarded to the following at the meeting of the Medical Fellowship Board in April:

S. Howard Armstrong, Jr., Harvard Medical School and the Peter Bent Brigham Hospital.

Joseph F. Ross, Evans Memorial Hospital, Boston, Massachusetts.

SCIENTIFIC NOTES AND NEWS

THE Benjamin Carver Lamme medal, awarded annually by the American Institute of Electrical Engineers for meritorious achievement in the development of electrical apparatus or machinery, was presented at the Cleveland meeting to Dr. Joseph Slepian, associate director of the Westinghouse Research Laboratories. The medal was awarded in recognition of his work on "the development of current-interrupting and current-rectifying apparatus. He developed the ignitron, an electronic tube now being used in aluminum and magnesium plants to convert alternating electric current required for the production of these metals."

MICHAEL LERNER, for his services to Chile in connection with his expedition in 1940 under the auspices of the American Museum of Natural History, has been awarded the decoration "Al Mérito" in the degree of "Comendador" by the Government of Chile.

DR. J. C. GEIGER, director of public health of San Francisco, recently received the award of fellow and "member correspondiente" of the National Academy of History of Panama.

WE learn from the *Journal* of the American Medical Association that on July 2, the eightieth birthday of Dr. Ludvig Hektoen, the Hektoen Institute for Medical Research of Cook County, Illinois, was dedicated in his honor. Dr. Morris Fishbein, editor of the *Journal,* presided at the ceremonies. The building, formerly the McCormick Institute for Infectious Diseases, has been purchased by the board of Cook County commissioners. A portion of the building is already in use. A plaque bearing a bas-relief of Dr. Hektoen was unveiled in the entrance of the institute. The presentation was made by Clayton F. Smith, president of the board of commissioners, and Dr. Karl Meyer received it on behalf of the institute.

AT a meeting on April 15 of the History of Medicine Society of Tulane University, as reported in the *Journal* of the American Medical Association, the Rudolph Matas award for the best paper on the history of medicine presented before the society was given to Charles M. Wilson, senior in the medical school, for his paper on "American Contributions to Neurosurgery." The I. I. Lemann Award for the best discussion before the society was presented to Dr. Leonard K. Knapp, junior in the medical school, for his discussion on aviation medicine. The presentations were made by Dr. B. Bernard Weinstein, instructor in gynecology in the medical school at New

Orleans. Harold Cummins, professor of microscopic anatomy, was the principal speaker, discussing "Extra Medical Interests of Charles Richet, Arthur Conan Doyle and Dr. Krandon."

THE University of California at Los Angeles at its commencement exercises on June 9 conferred the degree of doctor of laws on Dr. H. S. Jennings, research associate of the department of zoology, and Dr. H. J. Webber, emeritus professor of subtropical horticulture of the Citrus Experiment Station at Riverside of the University of California.

DR. F. W. HODGE, director of the Southwest Museum, Los Angeles, received the honorary degree of doctor of literature from the University of Southern California on May 23.

THE doctorate of science was conferred by the University of Oregon on May 30 at its sixty-sixth annual commencement on Dr. Ralph Albert Fenton, clinical professor of otolaryngology at the medical school of the university, and on Dr. Rosalind Wulzen, assistant professor of zoology at the State College. Citations by President Donald M. Erb read: "Ralph Albert Fenton: In recognition of his notable researches in the field of otolaryngology; his vital contributions to medical science; and his tireless efforts in advancing the standards of medical practice in the Commonwealth of Oregon. Rosalind Wulzen: In recognition of her outstanding contributions in the field of experimental biology; her nationally recognized researches on the subject of nutrition; and her discoveries related to calcium metabolism which have far-reaching clinical possibilities."

THE following officers of the University of Oregon Chapter of Sigma Xi for the year 1943–44 were elected at a meeting of the chapter on April 26: *President,* Dr. Pierre Van Rysselberghe, associate professor of chemistry; *Secretary,* Dr. John M. McGee, acting associate professor of chemistry, and *Treasurer,* Dr. Arnold L. Soderwall, instructor in biology. New members and associates were initiated at a meeting on May 15. The joint annual Sigma Xi-Phi Beta Kappa lecture was delivered by Dr. Arthur R. Moore, research professor of general physiology. He spoke on "The Two Great Books of 1543: Copernicus' 'De Revolutionibus Orbium Coelestium' and Vesalius' 'De Humani Corporis Fabrica.'"

ACCORDING to *The New York Times,* Dr. Frederic Joliot conjointly with Mme. Irene Joliot have been elected members of the French Academy of Sciences. Mme. Joliot is a daughter of Dr. Marie Curie.

AT Western Reserve University, Dr. J. Paul Quigley has been appointed professor of gastro-intestinal physiology and Dr. Edward Muntwyler has been appointed professor of experimental biochemistry.

DR. LEWIS M. TURNER, senior forester, Branch of Research, U. S. Forest Service, Washington, D. C., has been appointed dean of the School of Forestry and Range Management of the Utah State Agricultural College.

DR. ELMER H. STOTZ, director of the chemical laboratory at McLean Hospital, Waverly, Mass., and a member of the teaching staff in biochemistry of the Harvard Medical School, has been appointed by the Board of Trustees of Cornell University professor of agricultural and bio- chemistry and head of the Division of Chemistry at the New York State Experiment Station at Geneva. The appointment becomes effective on August 1. Dr. Stotz succeeds Dr. Donald K. Tressler, who resigned early in the year to enter the industrial field.

DR. HENRY D. BERGMAN, professor of veterinary physiology and pharmacology, has been named dean of the Division of Veterinary Medicine at Iowa State College, to succeed Dean Charles Murray. Dr. Murray will continue to serve both as head of the department of veterinary hygiene and as assistant director of the Veterinary Research Institute.

G. D. PRESTON has been appointed to the Harris chair of physics at University College, Dundee. Mr. Preston is known for his application of physical methods to metallurgical problems.

ROSCOE ROY SPENCER, medical director of the U. S. Public Health Service and assistant chief of the National Cancer Institute, Bethesda, Md., will become chief of the institute, the appointment to be effective on August 31. He will succeed Dr. Carl Voegtlin, who is retiring as director.

THE Board of Scientific Directors of the Rockefeller Institute for Medical Research announces the following promotions on the scientific staff, effective on July 1. *Assistant to Associate,* Dr. Merrill W. Chase, Dr. Stanford Moore, Dr. Isabel M. Morgan, Dr. Howard A. Schneider and Dr. William H. Stein. *Fellowship to Associate,* Dr. D. Wayne Woolley. *Fellow to Assistant,* Dr. Sidney Rothbard. The board also announces that Dr. Oswald T. Avery, who has reached the age of retirement, has been made member emeritus.

DR. CONRAD BERENS, of New York City, has been appointed civilian consultant in ophthalmology to the Office of the Air Surgeon.

ELMER S. RIGGS has been appointed honorary curator of paleontology at the Dyche Museum of the University of Kansas. This appointment takes effect as of June 2.

CHRIS L. CHRISTENSEN, dean of the College of Agriculture of the University of Wisconsin, has be-

come vice-president in charge of post-war development of the Celotex Corporation. He will also have charge of agricultural interests. Dean Christensen has been a director of the corporation since March, 1942.

T. W. HOWARD has been appointed superintendent of turbine and marine installations at the General Electric Company; E. L. Feininger has been appointed manager of the new division for resin and insulation material, and Dr. J. J. Pyle, group leader in charge of research and chemical development at the plastics laboratory at Pittsfield, Mass., has been appointed chemist in charge of the laboratory, succeeding Dr. G. F. D'Alelio, who has resigned.

EMMETT P. DUNN, curator of reptiles at the Academy of Natural Sciences of Philadelphia, left by airplane for South America on June 20. Serving under the auspices of the Committee for Inter-American Artistic and Intellectual Relations, he has been assigned to the Institute of Natural Sciences of the National University at Bogota, Colombia, to work on the collections of the reptiles and amphibians of the eastern slope of the Andes and to collect in the field.

A PARTY from the staff of Field Museum of Natural History began diving operations in Lake LaGrange at Dowagiac, Mich., on June 23 in order to complete studies necessary for the creation of an underwater habitat group of typical fresh-water fishes at the museum. Members of the party are Loren P. Woods, acting curator of fishes; Arthur G. Rueckert, staff artist; Leon L. Pray, taxidermist, and Frank H. Letl, preparator of accessories. The underwater studies are directed toward assuring a faithful reproduction in the museum exhibit of the submerged vegetation typical of the small lakes frequented by anglers in Michigan, Indiana, Illinois and Wisconsin. The fishes to be shown in the group include black bass, pickerel, yellow perch, wall-eyed pike, sunfishes, crappies, bullheads and minnows.

A CABLE dated June 24 from Guatemala to *The New York Times* states that a commission of sanitation experts, which is studying conditions along the route of the inter-American highway, had arrived at Guatemala. Dr. John R. Murdock, chief of the mission, is accompanied by Sanitary Engineers Charles C. Spenser, Herbert E. Hargis and Walter Dashiel. A careful study, which it is expected will be completed this year, is being made of drinking-water supplies, drainage and tropical diseases existing near the highway.

THE two hundred and fifty-sixth meeting of the American Physical Society will meet at Stanford University, California, on July 10. Following four contributed papers to be read at the morning session, invited papers will be given by L. Marton and Hardin Jones. The afternoon session will open with an invited paper by K. K. Darrow. Subsequent meetings are scheduled as follows: Chicago, November, 1943; Pacific Coast meeting, December, 1943, and the annual meeting, New York City, January, 1944.

A BILL to provide increased educational opportunities in Alabama has been signed by Governor Chauncey Sparks. $100,000 is appropriated annually for the Tuskegee Institute, of which Dr. F. D. Patterson is president. The bill provides that the fund be used for teaching graduate work in agriculture and home economics, and such other subjects as the board of trustees deems advisable.

ALBION COLLEGE has received the Charles W. Fallass herbarium as a gift to the college of the Fallass estate of Petoskey, Mich. Mr. Fallass graduated from the college in 1873. The herbarium contains approximately ten thousand specimens of both flowering plants and ferns mostly from Michigan, though many specimens have been secured by exchange from other parts of the United States, Canada, Mexico and countries abroad.

DR. ALEXANDER S. WIENER, head of the blood transfusion division at the Jewish Hospital of Brooklyn, has been awarded a grant of $3,000 by the United Hospital Fund, to carry on investigations on the prophylaxis and treatment of erythroblastosis fetalis.

THE U. S. Board of Education, under the E. S. M. W. T. program, has approved a series of courses in Sanitation Problems in Food Handling and Processing, sponsored by Manhattan (Engineering) College and the New York City Department of Health. Dr. J. H. Shrader has been retained to organize this course and direct the work of the instructors. The classes are organized into sections which deal with subjects of related content, such as baking, milk, meat, and others. Each class enrolls about twenty-five students and there are now eleven such classes, with a total of about three hundred students. The emphasis is chiefly on the technology of food production with a background of proper sanitary practice and understanding of the health problems involved. Open to high-school students without charge and conducted at college level, the course runs for six weeks of two sessions per week of three hours each. A certificate is issued by the New York City Health Department for those who successfully pass the course as determined by class work and final examination. A repeat series is scheduled to start about the middle of September. Those interested should write to A. D. Donovan, Manhattan College, Bronx, New York.

IT is reported in *The Lancet* that several medical schools expect to return soon to London provided that

essential repairs to their buildings can be undertaken. The medical students of King's College have already returned from Birmingham and the preclinical students of the Middlesex Hospital from Leeds, the London School of Medicine for Women is bringing back its preclinical students from Exeter and the London Hospital its preclinical students from Cambridge. The whole medical school of University College Hospital is also returning to London as the sector hospital which has been used for teaching is no longer available. Among the schools whose buildings have suffered extensive damage are University College and St. Bartholomew's Hospital Medical College, and these schools are considering schemes for temporary accommodation after the war so that their return to London need not wait upon the completion of the permanent buildings.

The Times, London, states that the Government of New South Wales is setting up a cancer institute at Sydney, the cost of which will be £100,000. Dr. Ralston Paterson, of the Holt Radium Institute, Manchester, England, is going to Australia to advise on the project.

THE British Institute of Chemistry hereafter will be known as "The Royal Institute of Chemistry of Great Britain and Ireland."

DISCUSSION

IMPLICATIONS INVOLVED IN MATHEMATICAL ADVANCES

HISTORIES of mathematics have seldom emphasized duly the fact that mathematical advances usually imply corresponding mathematical ignorance of the entire world up to the time when these advances were made. It is largely due to this fact that many educated people regard mathematics as a much older subject than it actually is. The numerous modern mathematical advances are greeted with applause, but their effectiveness would often be enhanced by exhibiting clearly to what extent they dispel ignorance relating to the same subjects. This is especially true as regards the history of mathematics since American contributions towards the advancement of this subject have thus far been unduly limited. Our writings thereon have been too largely confined to text-books which were usually not up-to-date even at the time of publication.

Advances in pure mathematics have always been within the reach of the poor and the rich alike since they required no expensive equipment. In this respect they differ widely from the achievements in warfare since the latter have always depended largely on the improvements in physical equipments, which, in turn, often encouraged the diffusion of mathematical knowledge. The free accessibility as regards advances in this subject constitutes an important element of its history because it tended to widen the variation of those working in this field. Those who contributed to the advancement of mathematics often worked in obscurity and with meager facilities.

For instance, J. V. Poncelet, who is commonly regarded as the creator of projective geometry, remarked in the first pages of his noted "Traité des propriétés projectives des figures" that this work was the result of researches which he undertook in the spring of 1813 in the prisons of Russia, where he obviously did not have much physical equipment for scholarly work. E. Galois, who greatly stimulated the early development of group theory, died before he was twenty-one years old when his work had as yet received little attention. He is the most conspicuous example of a mathematician whose present reputation depends almost entirely on the work of later writers who developed results which follow from ideas which he had announced but did not have time to master completely. His great modern reputation is evidence of a widespread desire on the part of the early mathematicians to give credit for the ideas which inspired their own work. It would be too idealistic to assume that this desire was universal or is universal now.

The history of mathematics is greatly enriched by the consideration of each decided advance in the light which it throws on the mathematical developments of all earlier times. For instance, the fact that H. Cardan published in his "Ars Magna" (1545) the earliest known solution of a quadratic equation having two complex roots sheds much light on all the earlier work relating to the quadratic equation, including that of the ancient Babylonians (about 2000 B.C.) and that of the ancient Greeks which was done more than fifteen hundred years later. The fact that the Norwegian surveyor, Caspar Wessel, published in 1799 the early satisfactory theory for operating with complex numbers by means of the fundamental operations of arithmetic throws much light on the extensive earlier use of these numbers during about two hundred and fifty years after the publication of Cardan's "Ars Magna."

This use of complex numbers before its legality had been established was not confined to mathematicians who received little recognition on the part of later writers on mathematics. It included Isaac Newton (1642–1727), who considered the number of the imaginary roots of an algebraic equation; G. W. Leibnitz (1646–1716), who factored $x^4 + a^4$ into its linear

rs and used them in the decomposition of fractions to partial fractions; John Bernoulli (1667–1748) ho exhibited the connection between the arc tangent d the logarithm of an imaginary argument, and eonhard Euler (1707–1783), who introduced in 1740 e use of imaginary exponents. The large number of teresting results which had been obtained by the use complex numbers before the legality of this use had en proved may partly account for the fact that this oof failed to attract much attention until many ars after it was first published. Correct results have equently inspired faith in the correctness of the thods employed and were often accepted as proof this correctness.

Although negative numbers were used much earlier an complex numbers, the solution of a quadratic uation having two complex roots seems to have eceded by about eighty-four years the solution of h an equation having two negative roots. The rliest known example of the latter appears in the nvention nouvelle" by A. Girard which was pub- ed in Amsterdam, 1629. The late appearance of h a solution directs attention to the fact that the neral use of negative numbers came much later than ght be inferred from the modern early use of them our schools. Among the late strong opponents to use of these numbers was Robert Simson (1687–8), who was professor of mathematics in the Uni- sity of Glasgow for forty years after 1711.

Hence it results that what the modern high-school dent is supposed to master easily gave much trouble noted professor of mathematics less than two hun- d years ago. Possibly the concealing of difficulties lementary mathematics is too frequently regarded simplification of the subject. While a clear ex- nation of the theory of operating with negative bers does not seem to be older than the corre- nding theory relating to complex numbers it is ear exaggeration to assert that "the one glimmer of hematical intelligence in the early history of nega- s is the suggestion of Fibonacci that a negative of money may be regarded as a loss." This as- ion appears in the "Development of Mathematics" E. T. Bell (page 158, 1940). On the contrary, the ent Babylonians already used the terms "tab" and " with respect to numbers as we now use + and – epresent distances in opposite directions from a line.[1]

G. A. MILLER

UNIVERSITY OF ILLINOIS

UNRECORDED CAUSE OF "RED WATER"

ED WATER has attracted the attention of seafarers early times. Various marine organisms have been cited as giving rise to this phenomenon, frequently ascribed to one or another species of dinoflagellate, as, for instance, *Gonyaulax polyhedra* off our own west coast, but never before do trochophore larvae seem to have produced it.

In 1935 I had the good fortune of accompanying Captain Allan Hancock, of Los Angeles and Santa Maria, California, on another of his memorable Pacific Expeditions aboard his motor cruiser, the *Velero III*, now in the service of the U. S. Navy. The third of January saw us headed southward off the coast of central Peru, angling across the Humboldt or Peruvian current. During that afternoon, while a little more than 50 miles to the westward of the Lobos de Tierra Islands (6° 28′ S., 81° 51′ 30″ W.), many patches of "red water" were seen all afternoon. A sample dipped up in a bucket from one of them was preserved in formalin for later study.

The contained organisms, thought at the time of collection to be peridinians, though very much plasmolized as the result of preservation, were unmistakably some species of trochophore larva, either mollusk or annelid. Dr. Martin Johnson, of the Scripps Institution, in commenting on the material says, "There is a possibility that the larvae could be those of a bivalve mollusk—the trochophore stage of gastropods usually occurs while yet enclosed in a case. I was, however, unable to make out any shell gland, a feature characteristic of bivalves in this stage. The trochal cilia also seemed to be more characteristic of annelids." He adds that it was perhaps not possible to settle the question from the specimens at hand. It is to be regretted that these larvae were not sufficiently far advanced in development to permit definite determination.

As trochophores apparently have not heretofore been observed as causing "red water," the fact that they were present in such enormous numbers as to give rise to this phenomenon seems worthy of note. No temperature reading was made at the time of the taking of the sample, but while on the same course the surface temperature at 10:05 A.M. registered 19.50° C. (6° S., 81° 41′ W.) and at 5:30 P.M., 20.32° C. (7° 50′ S., 81° 53′ 30″ W.).

Besides Dr. Johnson, I am also indebted to Dr. Herbert Graham, Mills College, and Dr. Olga Hartman, Allan Hancock Foundation, University of Southern California, for critically examining the sample; and to Captain Allan Hancock for permission to publish these notes upon it.

WALDO L. SCHMITT

U. S. NATIONAL MUSEUM

THE TEACHING OF TROPICAL MEDICINE

THE request of the armed forces that medical schools give more emphasis to tropical disease presents new

[1] *Cf.* O. Neugebauer, "Vorgriechische Mathematik," 18, 1940.

problems in methods of instruction. Most schools of medicine in the United States are located in regions where there are few if any examples of the important parasitic diseases, and hence clerkship or ward teaching is not possible. An alternative is a series of lectures or "dry clinics," supplemented by lantern slides and charts. This latter method is obviously deficient, since a thorough knowledge of a disease is rarely acquired without the study of patients. When a hospital patient is not available for study, the best substitute is the presentation of a case at a clinicopathological conference. In this exercise, if the case is treated as an unknown, it is possible to discuss the differential diagnosis and treatment in much the same way as in ward teaching. There is the added advantage that the pathologic changes can be presented at the conclusion of the clinical discussion.

At the Washington University School of Medicine an attempt has been made to develop the clinicopathological method of teaching tropical medicine. Representative gross specimens of specific cases, together with a full abstract of the clinical record, have been borrowed from other laboratories. The abstract is mimeographed and given to the staff and students two days in advance of the conference to allow ample time for study. At the conference the clinical record is briefly reviewed, and a senior clinician then discusses the differential diagnosis and treatment. Specific points are brought out by questions directed to members of the attending staff, each of whom has previously read the abstract and formulated an opinion. Finally the gross and microscopic observations and a summary are presented by the pathologist.

Since January 1, cases of leprosy, amebic dysentery, yellow fever and schistosomiasis have been presented in clinicopathological conferences to members of the third and fourth year classes of the medical school. The reaction of both the staff and the students has been sufficiently favorable to suggest that clinicopathological conferences may serve as a valuable method of teaching tropical medicine in medical schools of the United States.

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THE ELGIN BOTANIC GARDEN

THE question "Who Established the Elgin Botanic Garden?" which Dr. C. Stuart Gager puts as a title for his able article in SCIENCE, November 13, 1942, has arisen largely because certain reviewers of "Dr. Bard of Hyde Park" have implied that more credit should be given to Samuel Bard than to David Hosack.

It is fairly stated in my biography of Dr. Bard that his medical partner, Dr. Hosack, who was 27 years his junior, conceived the idea of the Elgin Garden in 1795 (p. 188). It was some six years later that Dr. Hosack purchased land for this botanic garden in what is now the midtown section of Manhattan, but in another six years he found the financial burden of maintaining the garden was too much for him to continue, and therefore in 1807 he offered the land for sale (p. 233).

At this point Samuel Bard came forward publicly and privately with the plea that the State Legislature should purchase the garden from Hosack and so establish it for posterity (pp. 243, 244). Even after this was accomplished in 1810 the maintenance of the garden was still a dilemma. The College of Physicians and Surgeons with Bard as president and Hosack as professor undertook to carry on the garden until in 1816 the land where now rises the Rockefeller Center was ceded to Columbia College. Thus in spite of Hosack's creation and Bard's sponsoring this ambitious adventure came to an end in 1819 so that the answer to the question seems to be that no one succeeded in establishing the Elgin Garden.

Another experimental garden which had its first inception in plans laid out by Samuel Bard in 17[illegible] (pp. 80, 81, 83) for his great-grandfather's estate on the Hudson River called Hyde Park, still continues, however, as a monument of the botanical effort of Bard and Hosack. This estate was purchased by David Hosack after the venerable Dr. Bard's death and has received expert care from subsequent owners to the present day. It is now part of the National Parks Service and is known to many as the setting for the Vanderbilt Mansion National Historic Site at Hyde Park. After the war it is planned to make the eighteenth century garden a center for those interested in the science of botany.

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SCIENTIFIC BOOKS

NICHOLAS COPERNICUS

Nicholas Copernicus, 1543–1943. By STEPHEN P. MIZWA. The Kosciuszko Foundation. 88 pp. 20 illus. 1 map. 1943. $2.00.

REGARDLESS of these tragic and turbulent times, the spirit of humanism and culture endures. This philosophy of life may not always be able to express itself, yet we have had many evidences these past centuries that civilization does survive where culture and learning prevail. One form of this evidence is truly

pressed by the Polish organization, "The Kosciuszko Foundation of New York."

The richness and fullness of life seems to increase with every advancement in the philosophy of pure science, art and literature. It is to those who have caused these advances that we in succeeding generations wish to pay tribute and to commemorate their works. These two years—1942 and 1943—are indeed epoch-making in recording the anniversaries of some of these great prophets. To name a few, we have Galileo (1564–1642) in physics; Newton (1643–1727) in mathematics and astronomy; Halley (1656–1742) in astronomy and meteorology; Lavoisier (1743–1794) in chemistry; Koch (1843–1910) in medicine, and Copernicus (1473–1543) in astronomy. There are various forms of commemoration, but usually these take place on some given date, such as birth or death. With Copernicus, however, we have the unusual experience of commemorating the first appearance of his great work, "De Revolutionibus Orbium Coelestium," 1543, which announced to the world, at his death-bed, the true order of the solar system, and from thence we found ourselves completely reorientated in the universe. Philosophically speaking, this influenced our minds to the extent that an intellectual revolution took place.

This beautiful brochure, prepared by Dr. Mizwa, is small in physical appearance, but incredibly rich in learning and humanistic philosophy. The material contained therein brings vividly to mind the life and work of the founder of modern science and observational astronomy. The greatness of Copernicus does not rest alone upon his clear formulation, through laboriously long series of observations of the movements of the planets in respect to the sun, but in reality he laid the foundation for the whole realm of modern celestial mechanics. Kepler, Newton, LaPlace, Gauss, Newcomb and a host of others followed in his footsteps.

Copernicus came from an old Silesian family, born 1473, in Torun, Poland, during the period this section was Germanic. At the outset, one is thoroughly awakened to the large amount of historical and bibliographical work necessarily involved in bringing to us this new picture of Copernicus's life. His manifold interests and activities, as given here, reveal what a full life, both secular and spiritual, he lived. The contents of this book is divided into four parts. Part I and Part II contain the salient features of his life, as well as the early concepts of our solar system. The doctrine of the Ptolemaic geocentric system, which prevailed for over 1,500 years, was finally supplanted by Copernicus's heliocentric system. This is followed by an account of Copernicus, the economist, which is indeed a new phase of the astronomer's life, not generally known. The principal activities during this period were in the formulation of the law of bad money with scientific precision, not evident in any of his predecessors. Newton faced the same problem for the British Crown in 1695–96. The third phase of this part treats upon Copernicus as a churchman, statesman and soldier, it being virtually a biographical sketch. This is followed by a section giving a brief account of the slow recognition of the new truth concerning the cosmic order.

In view of the scholarly research work manifested in this small book, we are here given, once and for all, the assurance that Copernicus was born a Pole, and not a German. Irrespective of political ties, blood ancestry has proven this to be true. He was the most inveterate enemy of the so-called "Knights of the Teutonic Order," then headed by Albert Hohenzollern, 1490–1568.

Part II, the Sarmaticus Astronomus (Sarmatia being the ancient name for Poland) consists of miscellaneous phases of the life of Copernicus, and the origin and meaning of the name, as well as some aspects of the territorial complex of Prussian Poland and the Corridor. Why the Poles are proud of Copernicus is because the whole civilized world claims him as its own.

Special attention should be called to the footnote references and bibliographical suggestions and comments. This to the reviewer's mind always makes a complete treatise. The last two parts relate to program suggestions, bearing particularly upon the quadricentennial celebration, and upon the educational reconstruction of Poland in the name of Copernicus.

Very few books are so well balanced in their selection of historical illustrations, such as portraits, statues, title-page facsimiles, etc., together with a rare print of his birthplace and the death scene of Copernicus. This last shows him dimly able to behold the first copy of his great work.

The art of the old world seems to have been transplanted to the American continent in the frontispiece. Seldom does one find such exquisite medieval art as is revealed in this beautiful example. The intricacies of the design and the brilliantly contrasting colors are here so vividly reproduced. The symbolism represents Copernicus as a churchman and a scholar—more specifically as an astronomer. The chain and cap are academic symbols. In the left hand he holds a device which illustrates one of his astronomical principles of planetary motion. In the upper right-hand corner is the coat-of-arms of the University of Kraków. But one must see it in order to fully appreciate the numerous details. This design was contributed by a refugee Polish artist, Arthur Szyk, perhaps the great-

est living miniaturist working in the technique of illuminated medieval manuscripts.

It is interesting to note that "De Revolutionibus Orbium Coelestium" is the rarest book in scientific literature to-day. The Union Catalogue of the Library of Congress records ten known copies of the first edition, Nürnberg, 1543, eleven known copies of the second edition, Basle, 1566, and six copies of the third edition, Amsterdam, 1617, in the United States and Canada.

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THE ELECTRON MICROSCOPE

The Electron Microscope. By E. F. BURTON and W. H. KOHL. 233 pages. New York: Reinhold Publishing Corporation. 1942. $3.85.

THIS book attempts the ambitious problem of taking a reader with infinitesimal knowledge of physics through the steps necessary to understand the electron microscope. There are, therefore, of necessity many inequalities of difficulty. However, the authors have succeeded as well as might be expected in this difficult task.

The first six chapters take the reader through some of the most elementary rudiments of optics, and the cartoon method of illustration is used freely with the objects and images depicted by cats, giraffes, etc., and where wave motion is explained by the picture of a child upsetting a pile of books. It is not to be expected that the reader who needs these devices will get a very clear comprehension of the "dual theory of light and of the electron" as propounded in Chapters 8 and 9; and the attempt to explain the motions of electrons in electromagnetic fields will probably be comprehensible to an appreciable degree only to those for whom the elementary parts are unnecessary. In this connection, the present reviewer feels that the statement on page 111 may lead the elementary student to believe that electrons starting with zero velocity continue to follow the lines of force. This they would strictly do only when moving with short mean free path as ions in a gas.

In spite of the foregoing unavoidable difficulties of presentation, the latter part of the book gives a very readable account of the potentialities of the electron microscope and of the essentials involved in its operation. The section dealing with the power of the microscope to reveal emission characteristics of thermionic emitters of various kinds will be of interest to many research physicists.

The book gives a clear picture of the orders of magnitude in relation to the various possibilities realizable with the electron microscope; and it will probably be of the greatest use to those who have no previous acquaintance with the microscope but are, nevertheless, beyond the stage for which the more elementary explanations would be necessary.

The implication on page 108 that a vessel containing millions of molecules represents a poor vacuum is probably a pure oversight, for, of course, a vacuum of 10^{-8} mm still contains about 3×10^8 molecules per cc.

RADIOACTIVITY

Kuenstliche Radioaktivitaet. By KURT DIEBNER and EBERHARD GRASSMAN. xi + 87. Leipzig: S. Hirzel. 1939.

THIS book seems to be a valuable compilation of data in the field to which it refers. It is of attractive form, and the material is well arranged. It will suffice to summarize its essential contents as follows, in which the reviewer has translated the titles from the original German:

Part 1: Induced Radioactivity by α-rays; Induced Radioactivity by Protons; Induced Radioactivity by Deuterons; Induced Radioactivity by Neutrons; Induced Radioactivity by Gamma-Rays.

Part 2: Tabular Presentation of all Stable, Natural and Induced Radioactive Isotopes with the most Important Data.

Part 3: Summary of all Stable, Natural and Induced Radioactive Isotopes, and the Transmutation Processes in Graphical Representation.

It is worth while calling special attention to the comprehensive chart contained in graph 3.

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NATURAL COLORING MATTERS

The Chemistry of Natural Coloring Matters. The Constitutions, Properties and Biological Relations of the Important Natural Pigments. By FRITZ MAYER, Ph.D. Translated and revised by A. H. COOK, Ph.D. American Chemical Society, Monograph Series, No. 89. 6¼ × 9¼ in. 354 pp. Bound in dark blue cloth. New York: Reinhold Publishing Corporation. $10.00. 1943.

THE book is divided into five chapters, each one of which has numerous references to the literature in the form of paginal footnotes. These chapters are: (1) Carotenoids (Polyene Pigments) (82 pp., 443 refs.); (2) Diaroylmethane Compounds (3 pp., 17 refs.); (3) Carbocyclic Compounds (59 pp., 240 refs.); (4) Compounds Containing Oxygen Heterocycles (10[illegible] pp., 512 refs.), and (5) Compounds containing Nitrogen Heterocycles (70 pp., 274 refs.). These chapters are followed by a brief General Bibliography, an Author Index and a Subject Index. The subject is presented compactly, access to further details being obtainable through the footnote references.

Paper, type, printing and binding are all excellent

and the book is profusely illustrated by constitutional formulas where structures are sufficiently well established to justify this. The tasks of the compositors and proofreaders in the case of some of the more complicated and extensive of these formulas must have been particularly laborious and difficult.

This masterly treatise, in the wealth of its documented information, its wide sweep and its up-to-dateness, is *facile princeps* among English books in its own chosen field. So far as the reviewer is informed, nothing at all comparable has appeared since the publication twenty-five years ago of Green and Everest's "The Natural Organic Colouring Matters." Between that date and this, the whole great field of the carotenoids, which is not even mentioned in Green and Everest's book, has experienced a marvelous development and elucidation. Carotene has been recognized as the precursor of the all-important vitamin A. The constitution of many of the carotenoids has been determined, as well as their exceedingly interesting chemical and biological relationships.

This carotenoid chapter also will enable the reader to see what has been contributed to this group since the appearance five years ago of a similar chapter in the first edition of Gilman's "Organic Chemistry."

Realms of still more recent exploration, which find a place in this new book, include the pigments of butterflies' wings, investigated by Wieland, Schöpf and their collaborators, and called by them "pterins." So that even the beautiful dazzling colors of butterflies and of certain insects have been unable to escape the insatiable prying curiosity of the chemist, who has proposed structural formulas for many of them.

Another and much more important field, which twenty-five years ago was largely a *terra incognita,* is that of the blood and bile pigments, to which Hans Fischer and his co-workers have made so many and such splendid contributions. The structural relationship of porphin to the phthalocyanine synthetic pigments of Linstead and his associates is a striking fact.

Curcumin, the principal pigment of turmeric, still remains pretty much in a class by itself (Chapter 2), so far as its chemical constitution is concerned.

Chapters 3 and 4 follow approximately the same general lines of chemical classification as Green and Everest, so far as the older natural pigments are concerned, and are enriched by many new compounds and illuminated by the light of numerous fresh investigations.

One of the chief contributing factors in the elucidation of the chemical nature of those natural pigments which are present so often in infinitesimal amounts has been the remarkable development of microchemical methods of all kinds, stemming from Pregl's pioneer work in the microanalytical field.

As noted in its sub-title, this book is concerned only with natural compounds possessed of visible color, *i.e.,* with pigments and not with dyestuffs as such. The tinctorial properties are incidental and not the governing factor in determining the appropriateness of including a colored compound. On the other hand, attention is constantly called to the absorbingly interesting biological relations and implications encountered.

The chemist will find in this book vistas into many new and fascinating worlds, often but little explored, which beckon alluringly and challenge the adventurous.

The book is warmly commended to all organic chemists. It is deeply to be deplored that the senior author could not have lived to see the fruition of his labors.

MARSTON TAYLOR BOGERT

SPECIAL ARTICLES

HUMAN COMPLEMENT[1]

THIS is a summary of a detailed study of human complement, including the structure and functions of the complement components.[2] The method used for the separation of the mid- and end-pieces of guinea pig complement proved to be inadequate for the separation of the corresponding portions of human complement. The method finally adopted consisted of dialysis of fresh human serum against a phosphate buffer of ionic strength 0.02 and pH 5.4. The dialysis is carried out with mechanical rotation at 1° C for 24 hours or longer, depending on the amount of serum employed. The precipitate, which corresponds to the mid-piece, is washed with cold phosphate buffer of ionic strength 0.02 and pH 5.4. If this precipitate is to be stored it is dissolved in a phosphate buffer of ionic strength 0.3 and pH 6.6.

The supernatant, which corresponds to the end-piece, is neutralized by the addition of 0.02 ml of 1N NaOH per ml, and made isotonic with 18 per cent. NaCl solution. The supernatant is best preserved at 1° C in 1:1.2 dilution in isotonic saline or in 1:2.5 dilution in phosphate buffer of pH 6.6 and ionic strength 0.3. The details of this method will be published elsewhere.

The mid-piece and end-piece obtained by this method

[1] Aided by a grant from the Commonwealth Fund.

[2] For earlier studies *cf.* Mackie, T. J.: *J. Immunology,* 1938, 5: 379; Osborn, T. W. B., "Complement or Alexin," London, Oxford Univ. Press, 1937.—Hegedüs, A., and Haxner, H., *Zeitschr. f. Immunitätsf.,* 1938, 92: 1.

are individually inactive but fully active when combined.

The human complement in one ml of human serum can be deprived of its third component by incubation at 37° C for 1 hour with 1.35 mg of the insoluble carbohydrate of yeast ("zymosan") prepared in this laboratory.[3]

The fourth component is inactivated with 0.2 ml of 0.16 M ammonium hydroxide per ml of fresh serum. The mixture is first shaken and incubated for 1 hour at 37° C; neutralization is then carried out by the addition of 0.032 ml of 1 N HCl. The fourth component can also be inactivated with hydrazine (0.1 ml of 0.16 M hydrazine per ml of fresh serum).

Human complement is inactivated at 52° C for 30 minutes by virtue of the destruction of C′2.

In summary, human complement is composed of four components similar to but not entirely identical with the components of guinea pig complement. It was found that the third component (C′3) is the only component which is effectively mutually substitutive in human and guinea pig complement systems. This is the only component that has features suggestive of enzymic nature. Human C′1 has been purified by ammonium sulfate precipitation and phosphate buffer extraction. It is characterized as a euglobulin with an electrophoretic mobility of 2.9×10^{-5} in veronal buffer of pH 7.8 and ionic strength 0.1. This preparation of C′1 comprises 0.8 per cent. of the total serum proteins. A protein fraction comprising 1 per cent. of the total serum proteins and containing nearly all C′2 has been prepared.

Evidence has been obtained to show that the bactericidal action of human serum against *Vibrio comma* is a result of the joint action of complement and antibody; and that this bactericidal effect is destroyed by the inactivation of any one of the four components of complement. The bactericidal action is restored to a specifically inactivated complement by the addition to it of the particular component which it lacks. It has also been found that the bactericidal action of whole human complement against this vibrio can be fortified by the addition of the end-piece (pH = 5.4 – μ 0.02 supernate) of human complement.

Fixations of whole human complement and specifically inactivated human complements to viable sensitized *Vibrio comma* have been investigated. From whole human complement nearly all of the C′3 activity is removed during fixation and only small amounts of the activities of the other three components are removed.[4] However, sufficient amounts of the components are fixed so as to cause the destruction of the vibrios. From complement deprived of C′3, the other three components are fixed to the sensitized organisms but bactericidal action is not exerted. However, when C′3 is added to this complex, bactericidal activity occurs.

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PIGMENT PRODUCTION BY SULFONAMIDE-RESISTANT STAPHYLOCOCCI IN THE PRESENCE OF SULFONAMIDES[1]

IN a previous report[2] the *in vitro* and *in vivo* production of sulfonamide-resistant strains of staphylococci was described. During the past year, investigations have been carried out concerning the mechanism of this resistance. Ten additional resistant strains of staphylococci have been shown to produce a substance which inhibits the antistaphylococcic action of the sulfonamides. It has been found that this inhibitory substance has several of the properties of p-aminobenzoic acid (PAB). These observations confirm the report of Landy and his associates,[3] who studied two sulfonamide-resistant strains of staphylococci supplied by us, and with a microbiological assay concluded that the sulfonamide inhibitor produced by these strains was PAB.

A standard test has been utilized for determining the *in vitro* resistance of staphylococci to the sulfonamides. The organisms were grown for several generations in a water-clear synthetic medium.[4] One tenth cc of a 10^{-3} dilution of a 24-hour culture was added to a series of tubes containing 10 cc of the medium with varying concentrations of sodium sulfathiazole. The contents were incubated for 48 hours at 37 degrees C, and bacterial growth ascertained and expressed in terms of turbidity. The growth of non-resistant strains of staphylococci was completely inhibited by less than 1 mg per 100 cc of sodium sulfathiazole; whereas, a concentration of 200 mgs or more was necessary for the sulfonamide-resistant strains.

While the foregoing studies on sulfonamide-resistance were in progress, an interesting and reproducible phenomenon was observed. Control cultures of either non-resistant or sulfonamide-resistant strains of staphylococci in synthetic medium attained the

[1] Aided by grants from the Charles P. DeLaitte Research Fund and from the Committee on Scientific Research of the American Medical Association.

[2] J. J. Vivino and W. W. Spink, *Proc. Soc. Exp. Biol. and Med.*, 50: 336, 1942.

[3] M. Landy, N. W. Larkum, E. J. Oswald and P. Streightoff, SCIENCE, 97: 265, 1943.

[4] G. P. Gladstone, *Brit. Jour. Exp. Path.*, 18: 322, 1937.

[3] *Jour. Biol. Chem.*, 137: 139. 1941.

[4] Human C′ has been found by Heidelberger and Mayer (*Jour. Exp. Med.*, 75: 285, 1943) to add roughly as much N to specific precipitates as does guinea-pig C′.

maximum degree of growth within 24 hours of incubation. At the end of this time, and also following a more prolonged period of incubation, the contents of the culture tubes revealed a white, turbid suspension of organisms. In the presence of increasing concentrations of sodium sulfathiazole, the more resistant strains produced a yellow color, which first appeared at the end of 24 hours of incubation. If the cultures remained at incubator or room temperature for another 24 to 48 hours, the color became more intense. The color was so pronounced with some strains that a deep brown-orange pigment was observed. This pigment appeared only in the presence of the higher concentrations of the sulfonamide, and uniformly, shortly after maximum growth had been attained. Strains, whose growth was completely inhibited by 200 mgs per 100 cc of sodium sulfathiazole, showed pigment production occurring in the presence of 40 to 100 mgs concentrations of the drug. There was little or no inhibition of bacterial growth in the tubes showing the presence of the pigment. The pigment appeared also in the presence of sulfanilamide, sodium sulfapyridine and sodium sulfadiazine. It is of interest that strains 7 and 14, which were studied by Landy and his group, did not produce a demonstrable pigment. These strains are not highly sulfonamide-resistant.

The nature of this pigment is being investigated at the present time. The pigment is not of the usual type produced by many strains of staphylococci, since it is not soluble in fat solvents. Evidence at hand would indicate that the pigment is derived from PAB. It would appear that under the experimental conditions described, some strains of staphylococci reproduce readily in the presence of the sulfonamides because of the synthesis of significant amounts of PAB. After maximum growth has been attained, the PAB is changed from a colorless state to a yellow-brown pigment.

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INTRA-OCULAR VIRUS INFECTIONS

IN investigation of the virus of epizootic fox encephalitis[1,2] we have found that the method of intra-ocular injection is a most useful procedure. This technique appears to be of great potential value in the study of other virus diseases. Observations of infections resulting from intra-ocular injections have been reported by a number of investigators in the virus field, principally in work on the pathogenesis of infections of the nervous system. It is felt, however, that the possibilities of this procedure have not been fully utilized in the approach to the more common problem of demonstrating the presence of viable virus.

Fox encephalitis can be experimentally transmitted to dogs, wolves and foxes. Evidence of infection has, in the past, consisted in death of the animal with characteristic symptoms and the demonstration of inclusion bodies in vascular endothelium in the brain and elsewhere. Studies of fox encephalitis have been hampered by a low or variable mortality of inoculated animals. This ranged from 10 to 80 per cent., depending upon the virulence of the strain of virus used and the natural resistance of the animals injected. Accurate titration of the amount of virus in tissue suspensions and the titration of antisera have been wholly impracticable, since the large number of foxes or dogs required was prohibitive. Employment of the simple technique of intra-ocular injection has changed this picture completely. Intra-ocular inoculation results in 100 per cent. infection of the eyes of foxes; the infection is easily observed grossly and is readily confirmed by demonstration of the inclusion bodies in smear preparations. Previously a 1 to 10 per cent. tissue suspension has been used[3] as an inoculum, but it has now been found that each of the several stock tissue suspensions tested was fully infective by intra-ocular inoculation in a dilution of 1 part in 100,000.

About 0.2 ml. of virus is injected into the anterior chamber after aspiration of a slightly greater volume of aqueous humor. Infection from the fox encephalitis virus is usually apparent grossly by the third day, and in all cases there is a diffuse opacity of the cornea on the fifth day. A significant amount of purulent conjunctival exudate is not seen unless bacterial infection has occurred.

On the fifth day the eye is removed either under anesthesia or after the animal has been killed. Aqueous humor is aspirated with a Pasteur pipette for bacterial culture. Inclusion bodies are demonstrated in the endothelial cells that line the internal surface of the cornea by the technique routinely employed in making smears of the epithelium of the urinary bladder in the diagnosis of canine distemper.[4] Using a modified Shorr's stain,[5] we have frequently found more than half of the cells in a smear to contain large inclusion bodies.

Neutralization tests are carried out by injecting mixtures of serum and virus dilutions into the anterior

[1] R. G. Green, N. R. Ziegler, B. B. Green and E. T. Dewey, *Am. Jour. Hyg.*, 12: 109–129, 1930.
[2] J. C. Barton and R. G. Green, *Am. Jour. Hyg.*, 37: 1–36, 1943.
[3] R. G. Green, N. R. Ziegler, E. T. Dewey and J. E. Shillinger, *Am. Jour. Hyg.*, 14: 353–373, 1931.
[4] R. G. Green and C. A. Evans, *Cornell Vet.*, 32: 190–193, 1942.
[5] W. G. Page and R. G. Green, *Cornell Vet.*, 32: 265–268, 1942.

chamber of the eye. The results are clear-cut and unequivocal, and may be verified by examination of smears. Exploration of the range of susceptible species of animals has been greatly facilitated by intra-ocular injection of virus. The raccoon, previously considered resistant to fox encephalitis, has been easily infected by this method. These results indicate that some viruses may be isolated and transmitted by intra-ocular inoculation of animals that are resistant to inoculation by other routes.

The eye contains many types of cells and is susceptible to a great variety of viruses. In a survey of the effects of intra-ocular injection, it has been found that infection is visible grossly in the eyes of rabbits when the animals otherwise appear well in equine encephalomyelitis, ornithosis[6] and several other virus diseases.

Failure to cause *visible* infection of animals that are susceptible (capable of supporting the multiplication of virus) is an obstacle to work with many virus diseases other than fox encephalitis; in some of these, as in fox encephalitis, intra-ocular injection should prove of great value. It appears that this may be a successful method for the initial demonstration of some viruses.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

PREPARATION OF METHIONINE AND TRYPTOPHANE-FREE CASEIN HYDROLYSATES[1]

TOENNIES and Kolb[2] have shown that methionine is selectively oxidized by hydrogen peroxide in the presence of perchloric acid. More recently, Toennies[3] has found that the methionine in casein is rendered biologically inactive by peroxide oxidation of the whole protein dispersed in formic acid. The concurrent observation made in this laboratory that methionine is also selectively oxidized by hydrogen peroxide in the presence of 30 per cent. sulfuric acid has been found to afford the simple and inexpensive procedure for the preparation of a methionine and tryptophane-free casein hydrolysate to be described.

One kilogram crude casein was hydrolyzed under reflux for 20 to 23 hours with a mixture of 500 ml concentrated sulfuric acid and 1 liter of water. After cooling to 80° C., 200 ml of 30 per cent hydrogen peroxide (technical) was added and the mixture allowed to stand 24 hours at room temperature. Now, 2 liters of water and 4 liters of 16 per cent. calcium oxide suspension were added. The slightly alkaline mixture was thoroughly stirred and resulted in the evolution of ammonia. After standing overnight, it was filtered through a norite-precoated filter and the resulting calcium sulfate cake resuspended in 2 liters of hot tap water. This mixture was stirred mechanically for 30 minutes, filtered and the combined filtrate and washings concentrated *in vacuo* at 50–60 ° to approximately 2 liters. The resulting ammonia-free concentrate was made neutral to litmus with 50 per cent. sulfuric acid, cooled under the tap and filtered.

The protein equivalence (N × 6.25) of the preparation was estimated from micro-Kjeldahl analysis of a suitable aliquot. Approximately 650 grams of methionine and tryptophane deficient product were obtained. The methionine content of the final product by the method of Kolb and Toennies[4] varied from 0.12–0.21 per cent. of the protein. No tryptophane could be detected.[5] Histidine, arginine, threonine and serine determinations indicated that these amino acids had not suffered any destruction by the treatment.

For use in a methionine deficient rat diet[6] the solution was supplemented by 1.5 per cent. l-tryptophane and 1 per cent. l-cystine. Bioassay in rats showed that the weight loss incurred by feeding the methionine deficient product as the protein moiety (14.7 per cent.) of the diet was regained and normal growth resumed on supplementation of the diet by 3 per cent. d-l methionine.

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[1] This investigation was aided by grants from the Rockefeller Foundation, Merck and Company and E. R. Squibb and Sons.

[2] G. Toennies and J. J. Kolb, *Jour. Biol. Chem.*, 140: 131, 1941.

[3] G. Toennies, *Jour. Biol. Chem.*, 145: 667, 1942.

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